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"A Study of the Metallic and Stony Meteorites by
Means of Electron Microprobe X-Ray Analyses"

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Summary of Completed and Current Research

A. Use of Microprobe to Determine Compositions and Composition Gradients in Fe-Ni-X Systems

This study of non-metallic phases existing in pallasites (schreibersite, troillite and forrsterite) was started with a sample of the Brenham, Kansas, meteorite. The requirements of the sample holder in the ARL microprobe restricted specimen thickness to $\frac{1}{4}$ ". Specimens of this thickness were cut and polished according to established procedures. The desired areas for analysis were identified, photographed and analyzed with the microprobe. Subsequently, the carbon coating deposited to provide electrical conductivity was removed, the samples were placed in a tube, flushed and evacuated repeatedly with Argon, heated to 100°C in vacuo. After 1 hour at this temperature, the sample was re-evacuated and reflushed several times. It was considered a dry specimen at this point. There was, however, an apparent very thin oxide layer on the metal surfaces. The sample was returned to the furnace in the evacuated tube and heated to 200°C for 100 hours at which time the sample fell to bits. Furthermore, distillation rings were observed on the cool end of the tube (Fig. 1). The apparent oxide layer was only slightly darker. Fig. 2 shows, from left to right, a plastic encapsulated reference specimen, a specimen ready for heat treatment, a specimen following the preliminary drying treatment, and the debris of a 200°C heat-treated specimen. Since 200°C is much too low a temperature for meaningful phase equilibrium data to be obtained, these preliminary results showed the impracticability of studying multiphase systems at higher temperatures using this procedure. One of the primary goals of this particular investigation was the element distribu-

tion at the phase boundaries. The break-up of the aggregate at such low temperatures, in addition to eliminating diffusion across such boundaries, indicates either the production of decomposition products or disruptive thermal stress or both.

B. Phase Equilibria in Metallic Phases

The study of phase equilibrium has been continued with the investigation of the structures and composition of the metallic phases comprising and immediately associated with plessite. A paper is in preparation on the plessite of octahedrite meteorites. For further information on this subject we are enclosing the preliminary draft of the paper.

With respect to the metallic phases in pallasites and the stony meteorites, an interesting similarity between the structures and composition of the metal existing in the different classes of meteorites has been observed. The M profile or half-M profile as discussed by Wood¹ and Goldstein and Ogilvie² exists at α - γ interfaces of pallasites and some stony meteorites. The gross agreement with the M profiles seen in octahedrites is demonstrated in Fig. 3. This figure shows superimposed two examples that represent entirely different conditions of nucleation and growth. Further work on the metallic phases in the stony irons anticipates defining the observed structures in terms of known mechanisms.

C. Non-Metallic Phases

In the study of the non-metallic phases element profiles have been determined for Si, S, P, Mg, Fe and Ni across appropriate phase boundaries.

As part of the study of the temperature dependence of the diffusion zones between various metallic and non-metallic phases, element profiles have been determined for Si, S, P, Mg, Fe and Ni where measurable concentrations of these elements exist. Although the high-temperature studies could not be carried out, the element profiles at room temperature of some of these boundaries raise some interesting possibilities.

a. Much of the schreibersite observed in α iron appears to have formed as the result of solid state precipitation of the Fe-Ni phosphide from the kamacite phase as it grew at temperatures below 700°C. The gradients of Ni found at the junction of kamacite-phosphide areas in the Brenham pallasite indicate the same excess and depletion of Ni at the boundaries as that observed for similarly formed phosphides in the octahedrite meteorites.

b. The Mg, Ni, and Fe concentrations were determined across a forrsterite- α iron- γ iron region in the Brenham pallasite. The Ni-Fe ratio changed across the α - γ interface in a manner similar to that observed in octahedrites. The Ni-Fe ratio in the α iron at the α -iron-forresterite interface changed in a manner similar to that of the α side of the α - γ boundary. This observation raises some question about the Ni distribution in the adjoining non-metallic phases and the possible equilibrium conditions that might have existed.

References

1. J. A. Wood, *Icarus*, 3, 429 (1964).
2. Goldstein, J. I. and Ogilvie, R. E., *Trans. AIME*, in press.

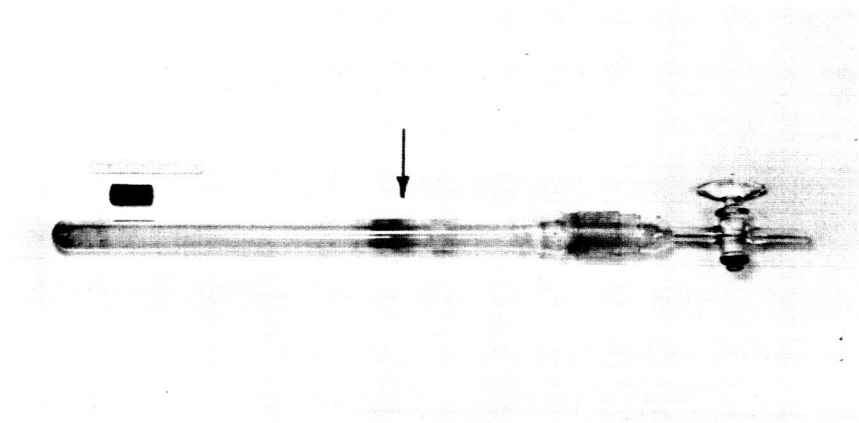


Fig. 1



Fig. 2

Fig 3

